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TECHNICAL MEMORANDUM

X-273

EFFECTS OF SPOILER-SLOT-DEFLECTOR CONTROL ON THE AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 2.01 OF A VARIABLE-WING-SWEEP CONFIGURATION WITH THE OUTER WING PANELS SWEPT BACK 75°

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SUMMARY

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An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 2.01 to determine the aerodynamic characteristics of a variable-wing-sweep configuration equipped with a spoiler-slot-deflector control. The outboard wing panels were swept back 75°.

The results indicate that the spoiler-slot-deflector control provided positive roll effectiveness which was approximately constant through the angle-of-attack range and positive yawing moments which decreased with increase in angle of attack. Deflection of these controls had no appreciable effect on the longitudinal stability characteristics.

INTRODUCTION

A study currently being conducted by NASA to determine the stability and control of a variable-wing-sweep configuration has indicated that, with the outer wing panels swept back 75°, flap-type ailerons would not provide sufficient roll control in the subsonic speed range (ref. 1). This deficiency in roll control could be overcome through the use of a differentially deflected horizontal tail (refs. 1 and 2); however, differential deflection would appear to make the tail design unduly complex. Another means of providing roll control would be through the use of a spoiler in combination with a slot and deflector. Controls such as these have been found to be effective through a speed

*Title, Unclassified.

range up to supersonic speeds (refs. 3 and 4) for 45° sweptback wings; however, no data are available for wings of higher sweeps. Accordingly, a spoiler-slot-deflector control system was adapted to the variable-wing-sweep model to determine the lateral control characteristics of such a device for higher wing-sweep angles.

This paper presents the results of an investigation at a Mach number of 2.01 of two spoiler-slot-deflector controls of different lengths - 23-percent and 52.7-percent wing semispan - at various deflection angles on a variable-wing-sweep configuration with outer wing panels swept back 75°.

COEFFICIENTS AND SYMBOLS

The results are referred to the body-axis system except the lift and drag which are referred to the wind-axis system. The moment reference point is located on the body center line at a station 66.1 percent of the body length.

The coefficients and symbols are defined as follows:

C_L lift coefficient, $\frac{\text{Lift}}{qS}$

C_D drag coefficient, $\frac{\text{Drag}}{qS}$

C_m pitching-moment coefficient, $\frac{\text{Pitching moment}}{qS\bar{c}}$

C_l rolling-moment coefficient, $\frac{\text{Rolling moment}}{qSb}$

C_n yawing-moment coefficient, $\frac{\text{Yawing moment}}{qSb}$

C_Y side-force coefficient, $\frac{\text{Side force}}{qS}$

q free-stream dynamic pressure

S wing area including fuselage intercept, 1.916 sq ft

c local chord, in.

$\bar{c}$ wing mean geometric chord, 13.64 in.

b wing span, 22.68 in.

A aspect ratio

t thickness

α angle of attack, deg

δ_s spoiler angle measured with respect to wing-chord plane (fig. 1(b)), deg

δ_d deflector angle measured with respect to wing-chord plane (fig. 1(b)), deg

MODELS AND APPARATUS

Details of the model are shown in figure 1(a). The forward 40 percent of the body was composed of straight-line conical elements that faired into an afterbody of constant cross-sectional area and shape. The afterbody was composed of flat top and bottom surfaces and semicircular sides. The wing was mounted on the body center line with zero dihedral and incidence. The sweep angle of the wing leading edge was 60° out to about 65.4 percent of the semispan, at which point the sweep angle increased to 75°. The trailing-edge sweep angle was constant at 42.5°. The wing was composed of NACA $63_{(06)}$A004.5 sections normal to the leading edge. The horizontal and vertical tail panels were identical in plan form. The horizontal tail was mounted on the body center line with a dihedral angle of -15°. The incidence of the horizontal tail was set at 0° throughout this investigation.

For this investigation an additional outer wing panel equipped with a 15-percent-wing-chord spoiler-slot-deflector control was constructed. The control extended from 29.8 percent to 82.5 percent of the wing semispan. (See fig. 1(b).) Provisions were made for deflecting only the inboard (23-percent-wing-semispan) part of the control or for deflecting the entire 52.7-percent-wing-semispan control. The slot was designed to extend from 0.60 to 0.75 chord for the subsonic wing configuration, for which the outer wing panels are swept back 12.5° (ref. 1).

The model was mounted in the tunnel on a remotely controlled rotary sting, and force measurements were made through the use of a six-component internal strain-gage balance.

TEST, CORRECTIONS, AND ACCURACY

The test conditions were as follows:

Mach number	2.01
Stagnation temperature, °F	100
Stagnation pressure, lb/sq in.	5
Reynolds number based on $\bar{c}$	1.24×10^6

The stagnation dewpoint was maintained sufficiently low so that no condensation effects were encountered.

The tests were made through an angle-of-attack range from 0° to 11° at a sideslip angle of 0°. Spoilers were deflected 30°, with deflector angles of 15° and 22.5°, and 60°, with deflector angles of 30° and 45°.

The angles of attack were corrected for deflection of the balance under load. The base pressure was measured and the drag force was adjusted to a base pressure equal to free-stream static pressure.

The estimated accuracy of the data is as follows:

C_L	±0.0080
C_D	±0.0011
C_m	±0.0015
C_l	±0.0080
C_n	±0.0003
C_Y	±0.0003
α	±0.1

SUMMARY OF RESULTS

The effects of both the 23-percent- and the 52.7-percent-wing-semispan spoiler-slot-deflector controls on the lateral aerodynamic characteristics of the model are presented in figures 2 and 3. In general, both lengths of the control provide positive roll effectiveness and positive yawing moments at $\alpha = 0°$. The effect of these controls on the rolling moment was approximately constant with increase in α whereas the effect on yawing moment decreased with increase in α.

The effects of the two spoiler-slot-deflector controls on the longitudinal aerodynamic characteristics are presented in figures 4 and 5. Deflection of these controls had no appreciable effect on the longitudinal stability but did result in an increase in drag.

Langley Research Center,
National Aeronautics and Space Administration,
Langley Field, Va., January 6, 1960.

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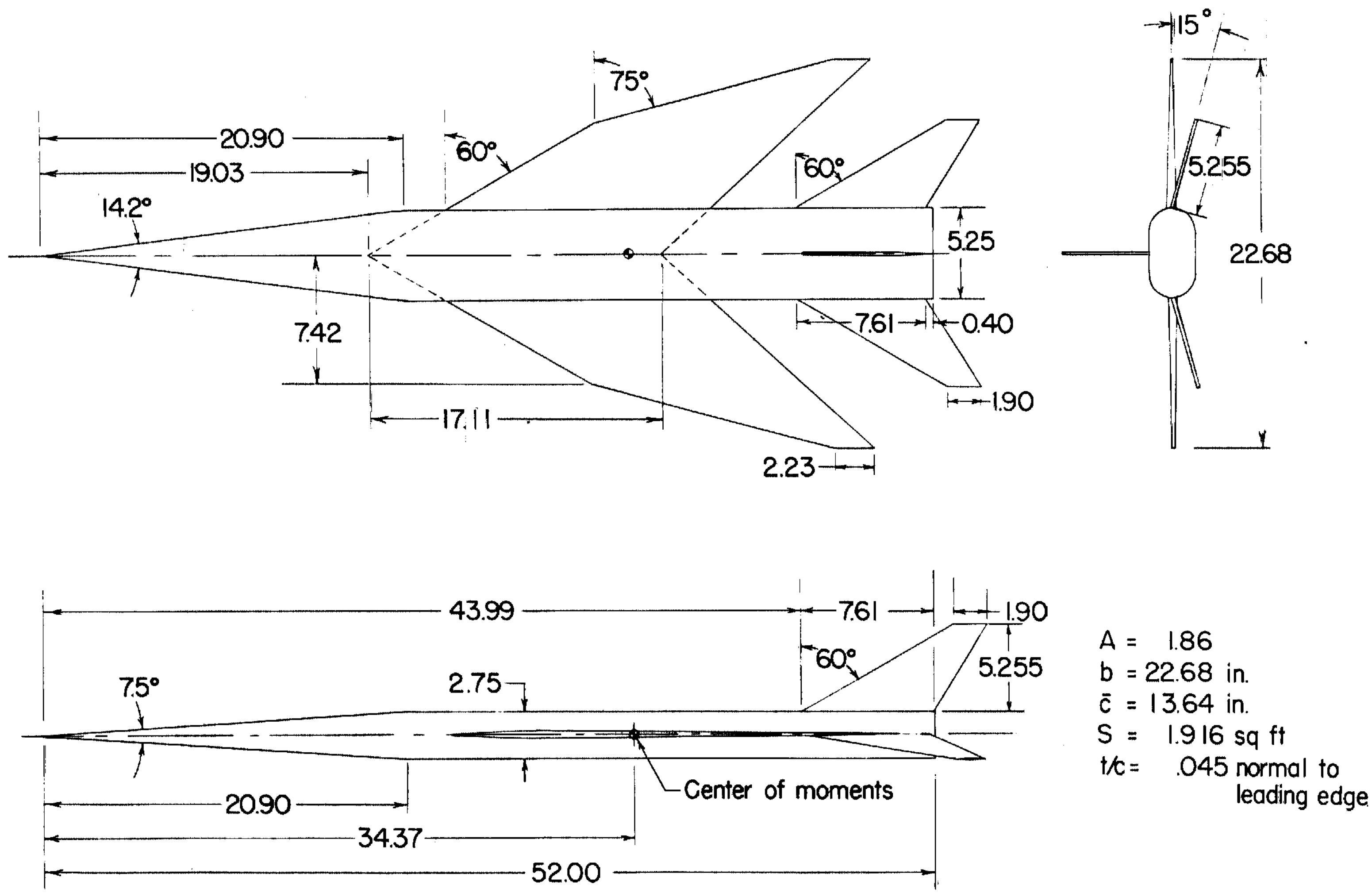
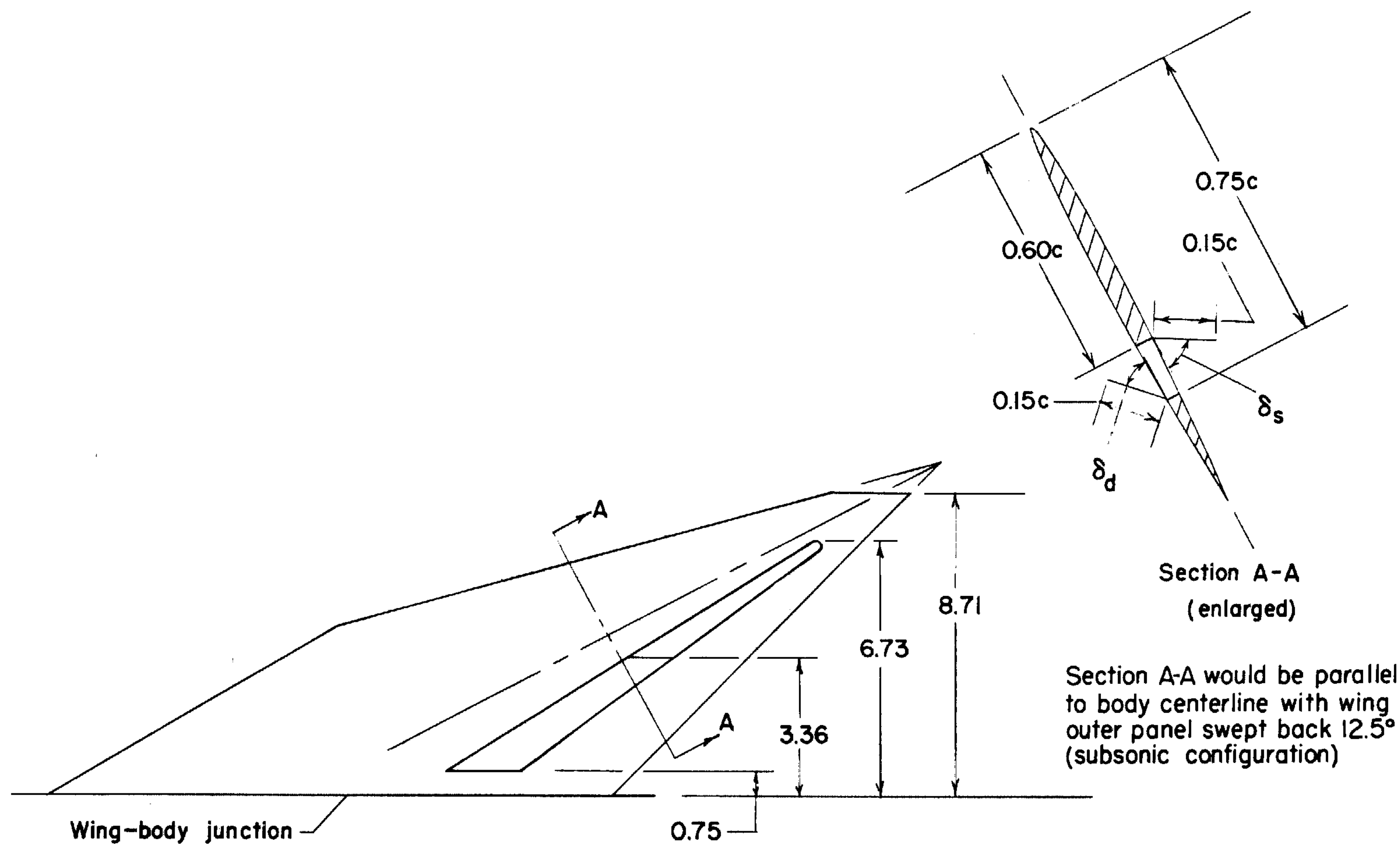


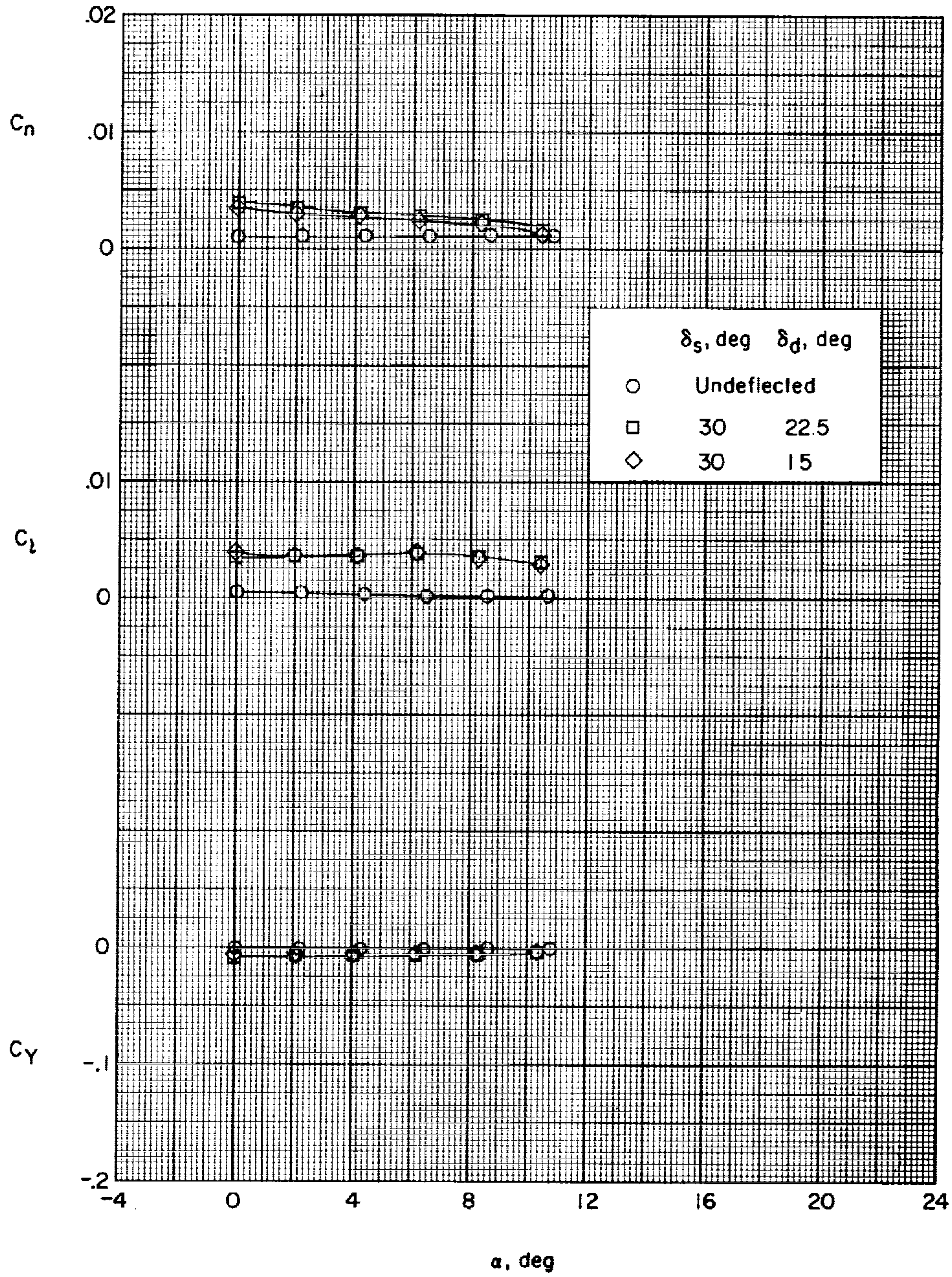
(a) Basic configuration.

Figure 1.- Details of model. All dimensions are in inches unless otherwise noted.



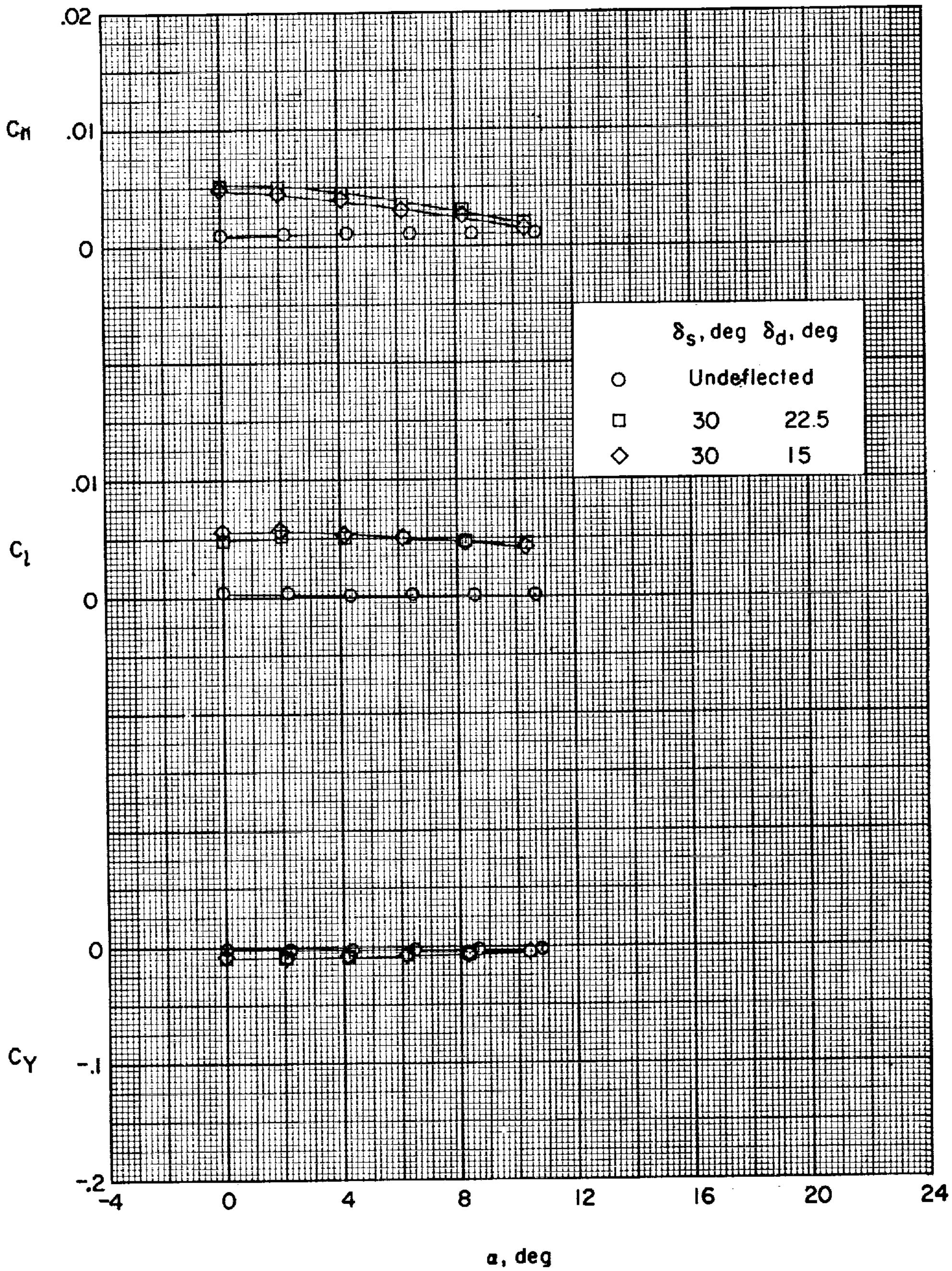
(b) Details of spoiler-slot-deflector control.

Figure 1.- Concluded.



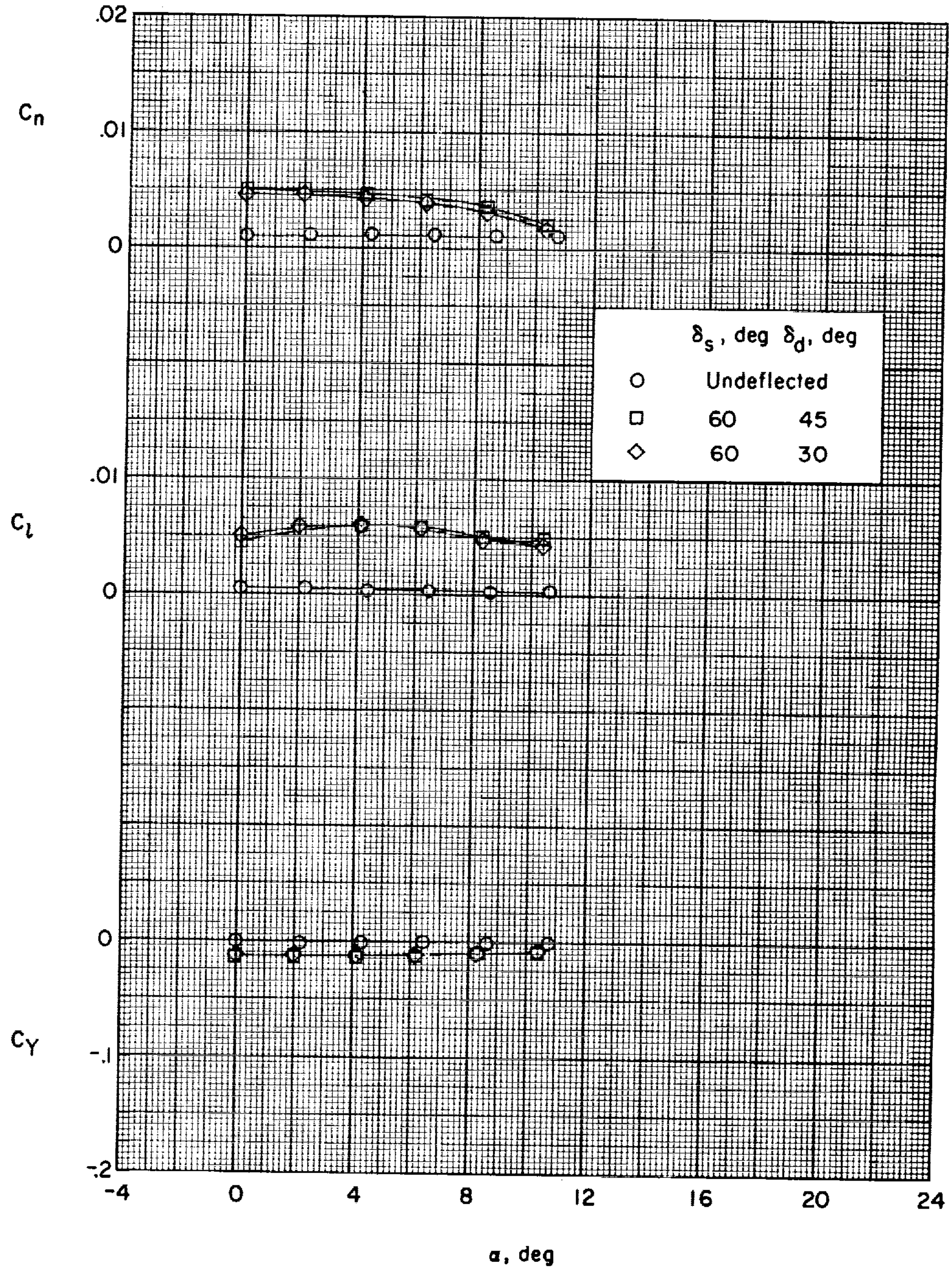
(a) 23-percent-semispan control.

Figure 2.- Effect of various deflector angles in combination with a spoiler deflected 30° on the lateral aerodynamic characteristics.



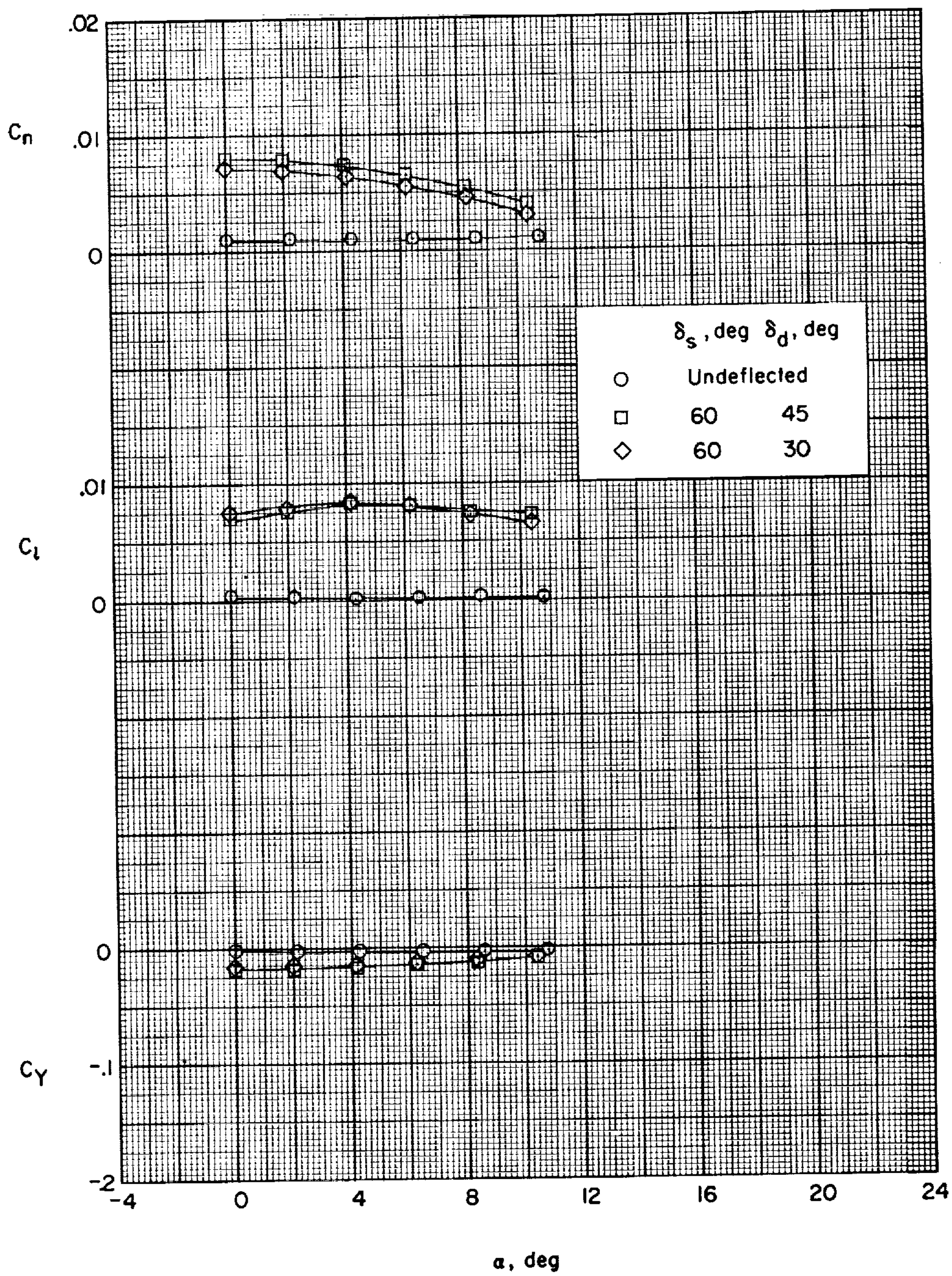
(b) 52.7-percent-semispan control.

Figure 2.- Concluded.



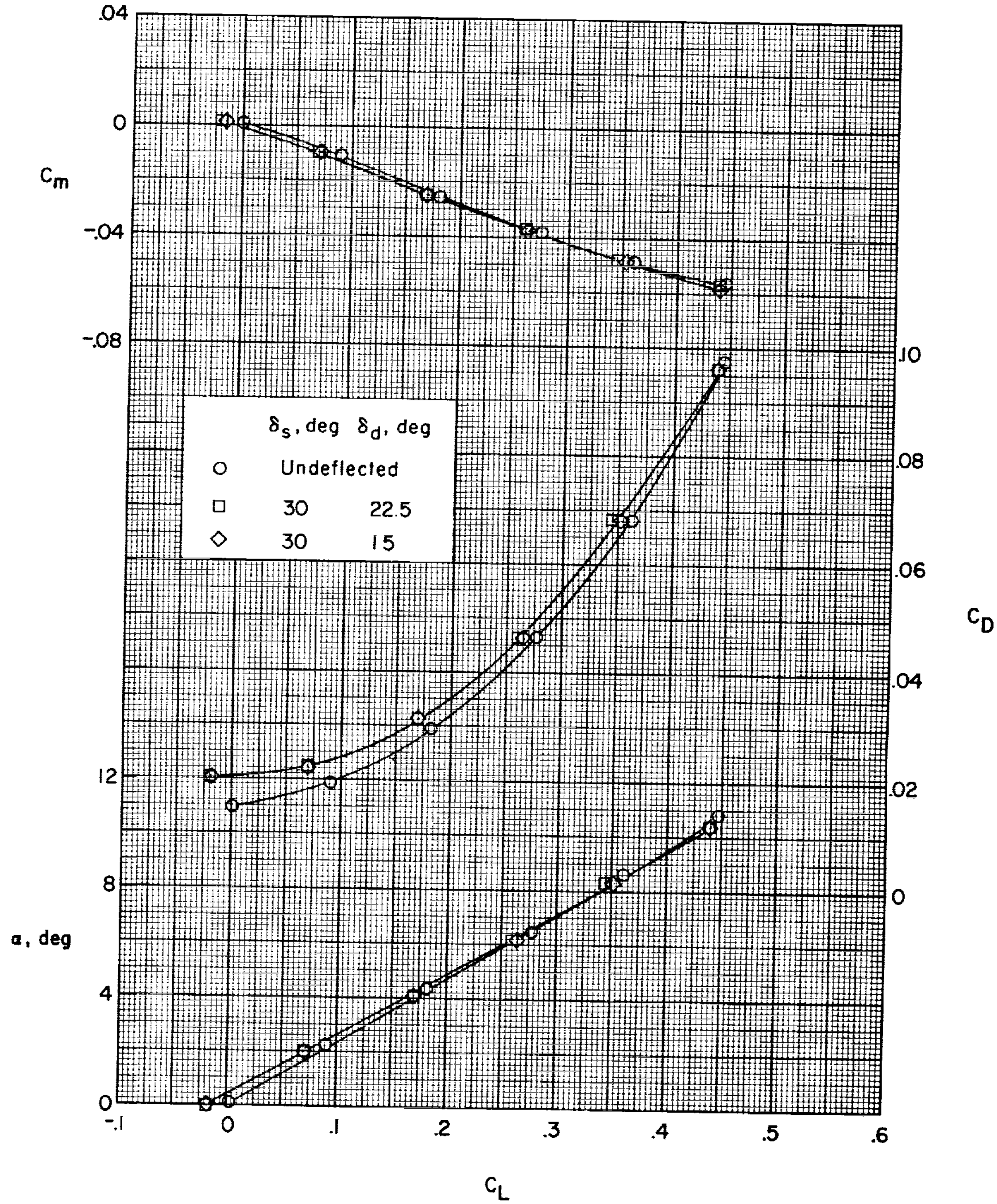
(a) 23-percent-semispan control.

Figure 3.- Effect of various deflector angles in combination with a spoiler deflected 60° on the lateral aerodynamic characteristics.



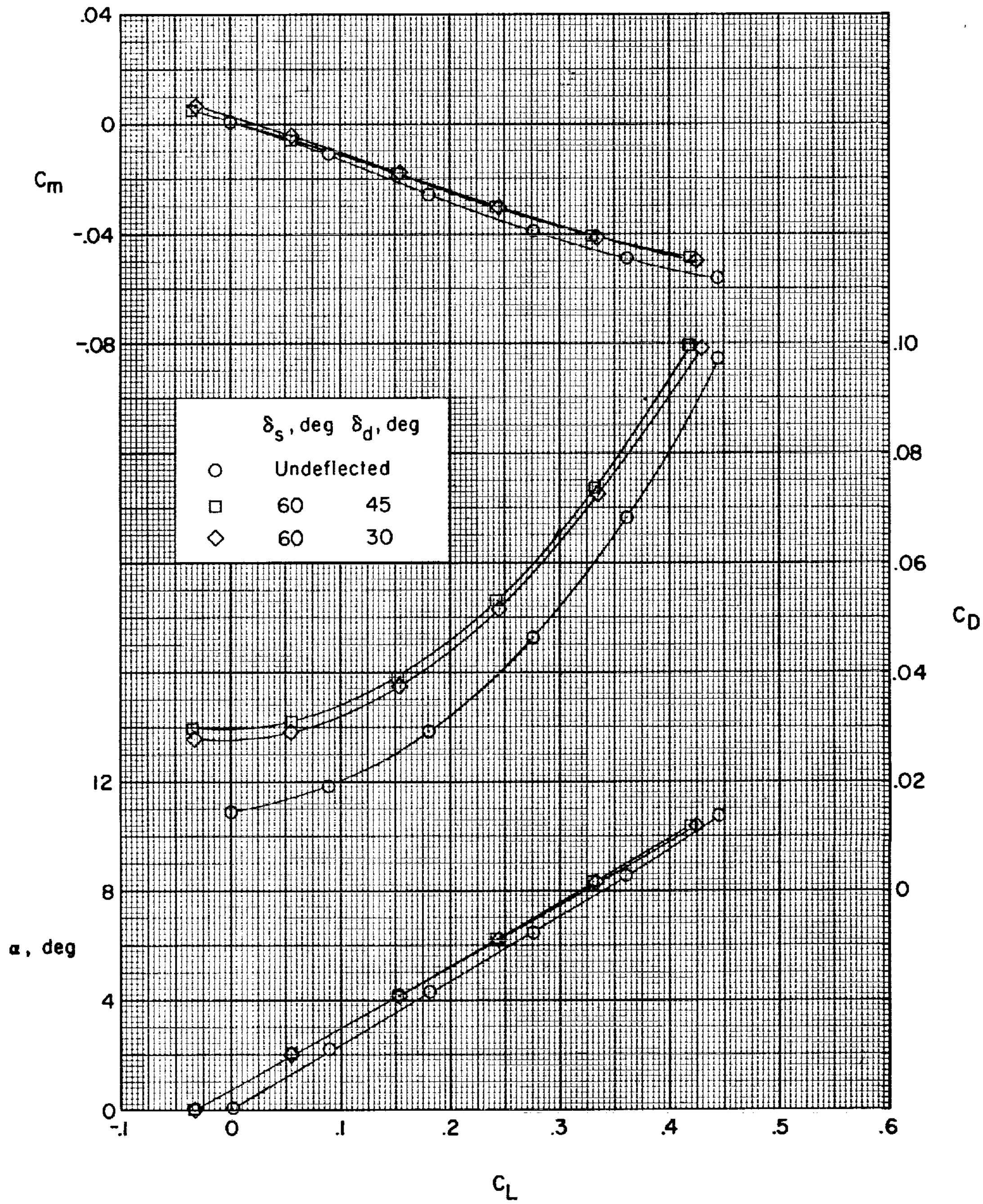
(b) 52.7-percent-semispan control.

Figure 3.- Concluded.



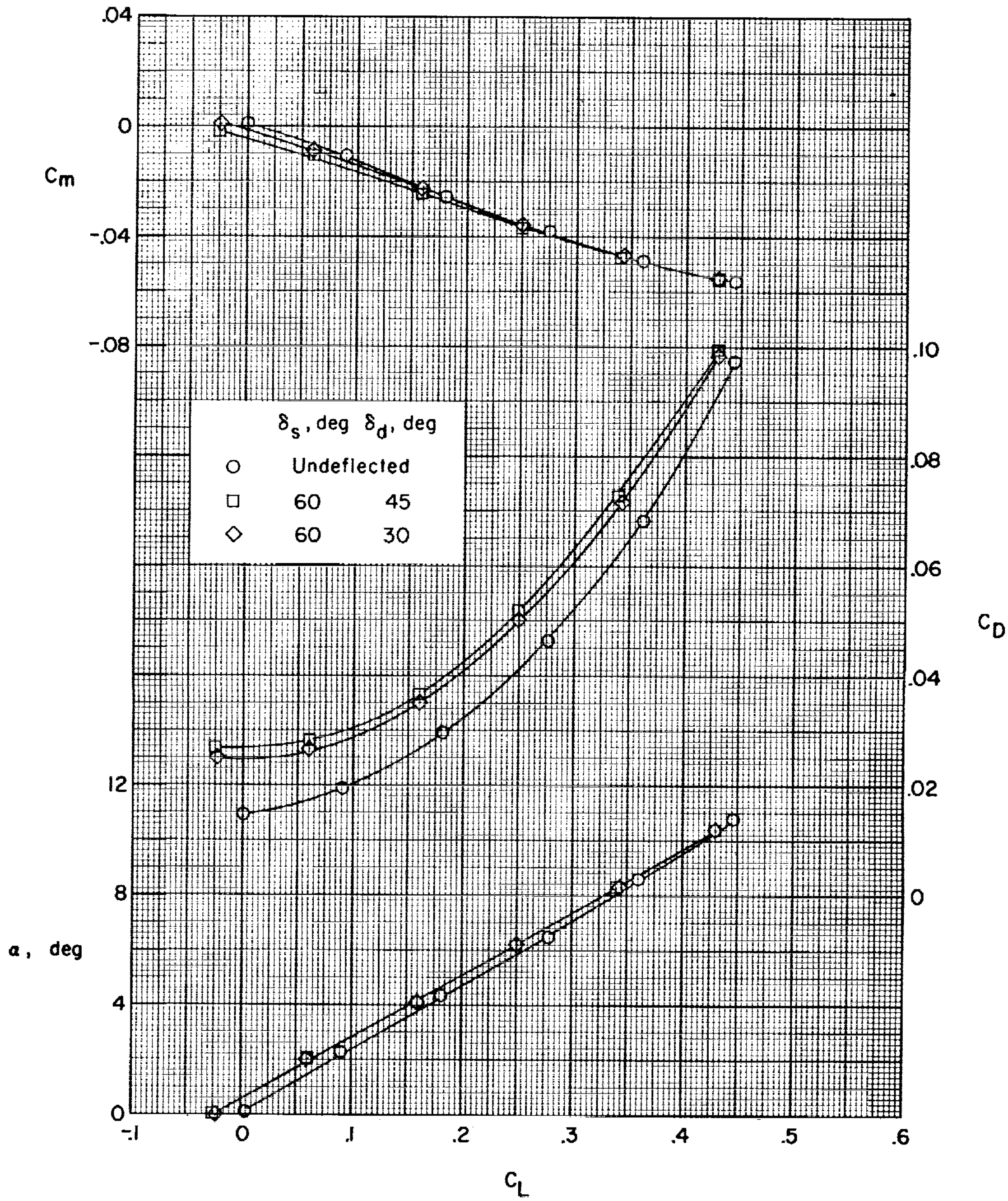
(a) 23-percent-semispan control.

Figure 4.- Effect of various deflector angles in combination with a spoiler deflected 30° on the longitudinal aerodynamic characteristics.



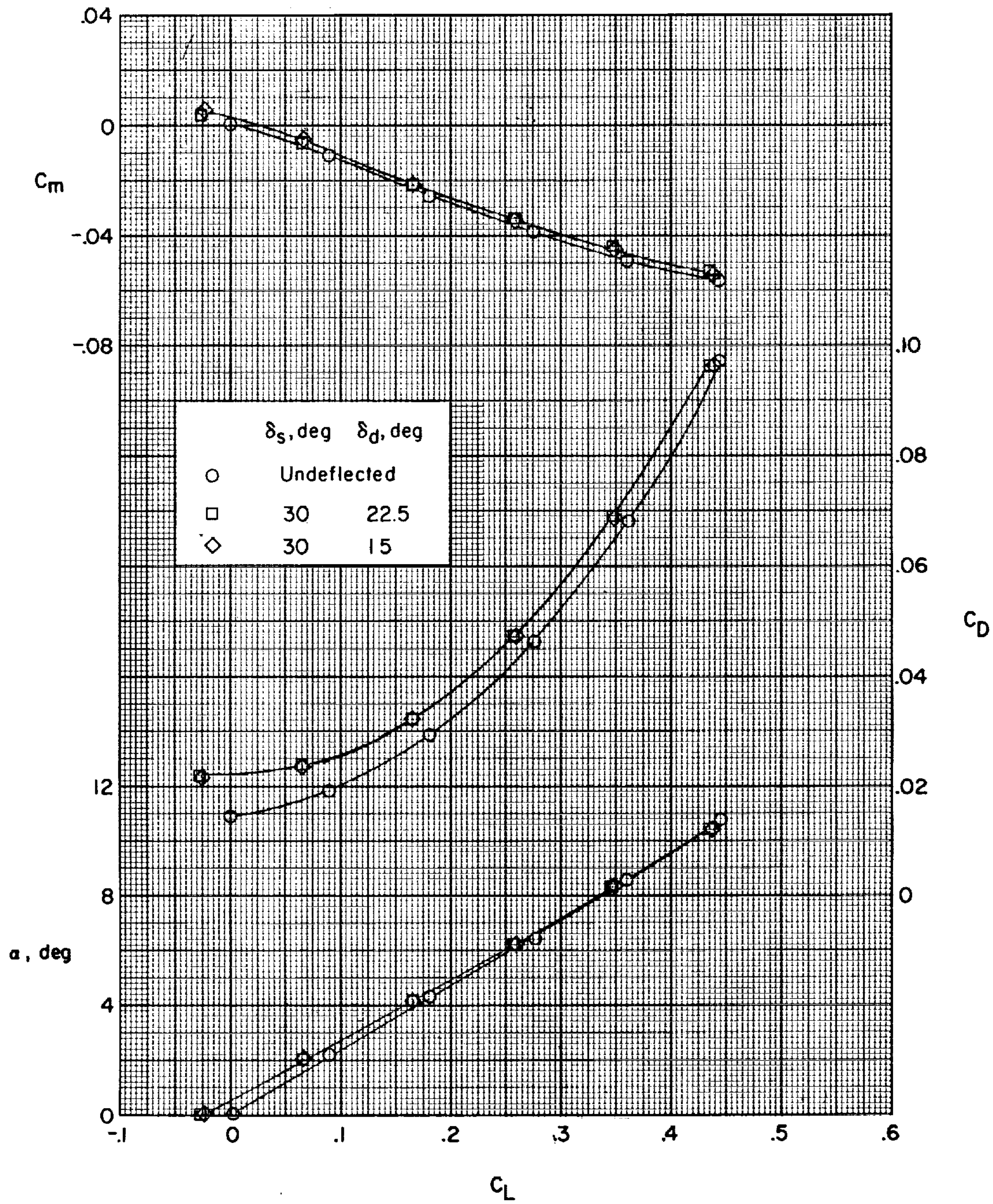
(b) 52.7-percent-semispan control.

Figure 4.- Concluded.



(a) 23-percent-semispan control.

Figure 5.- Effect of various deflector angles in combination with a spoiler deflected 60° on the longitudinal aerodynamic characteristics.



(b) 52.7-percent-semispan control.

Figure 5.- Concluded.

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